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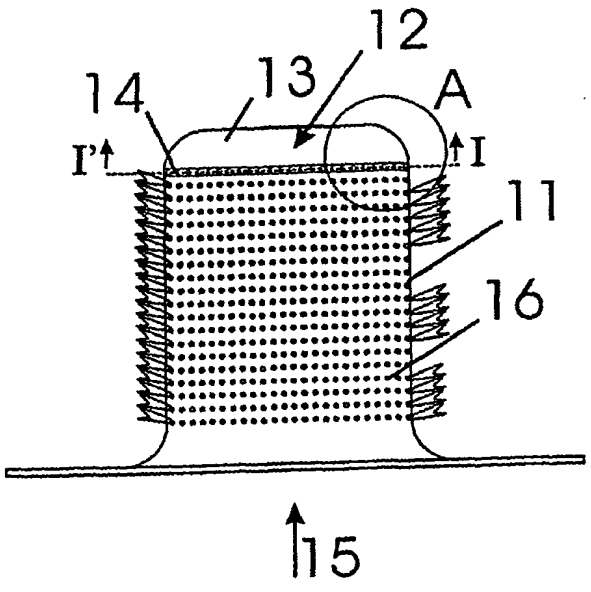
(54) Title: PREMIX BURNER WITH CURVED IMPERMEABLE END CAP



(57) Abstract: The invention relates to a premix burner comprising a tubular burner body and an impermeable end cap. The impermeable end cap, which closes the tubular burner body, is welded to said tubular burner body The impermeable end cap is, according to the present invention is at least partially curved, each point of the impermeable end cap surface having a bending radius R and a material thickness T, said each R being larger than 3xT.

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PREMIX BURNER WITH CURVED IMPERMEABLE END CAP

Field of the Invention.

The present invention relates to a premix burner for combustion of premixed gas-air mixtures.

Background of the Invention.

Premix burners are well known to the state of the art. Some of these premix burners comprise a tubular burner body. Such a burner is described in US5022352, where it is used to heat the water of e.g. a central heating system.

Such premix burner comprising a tubular burner body, preferably made out of steel plate, having along its tubular burner body at least one, but usually several matrixes of burning slots and/or holes. The tubular burner body is closed at one side by a so-called end cap. When the end cap is not provided with burner slots, the premix burner as known in the art may show some defects after a certain period of use.

Nowadays, the working conditions of premix burners in general become more severe, due to higher requirements of the burning circumstances. Premix burners nowadays are to be able to modulate the air-gas throughput over a wider range. Especially, premix burners have to be able to burn very low amounts of air-gas mixtures. Hence, during a low throughput of air-gas mixture, the combustion is situated very close to the tubular burner body. The lower the throughput, the closer the flame front is situated near the tubular burner body. A part of the combustion energy will heat the tubular burner body and the end cap, so causing thermal expansion of both tubular burner body and end cap. Especially when the end cap is not provided with burner slots (hereafter referred to as "impermeable end cap") difference in thermal expansion may occur between both elements, being end cap and tubular burner body, due to e.g. different temperatures of both elements, or different thermal

expansion coefficients of both elements. The tubular body is heated to higher temperature levels, due to a closer flame front, and is so subject of more severe thermal stresses. This difference may cause thermal cracks, especially at the welding zone of both elements.

Summary of the invention.

It is a subject of the present invention to provide tubular burner bodies, which are able to resist better the severe thermal expansions at the connection between tubular burner body and impermeable end cap, both parts made out of metal, usually steel plate.

According to the present invention, a premix burner comprises a tubular burner body, an impermeable end cap and possibly a diffusion system, located inside the tubular burner body. The tubular burner body comprises at least one matrix of burning slots and/or holes on its surface. Premix air-gas mixture is blown into the tubular burner body via an appropriate inlet, usually at the lower side of the tubular burner body. Since the tubular burner body is closed at the other side by the impermeable end cap, the air-gas mixture is forced to flow, possibly via an air-gas diffuser, through the burning slots and/or holes, where combustion takes place.

According to the present invention, it was found that the risk on thermal cracks may be avoided to a large extend, by welding an impermeable end cap to the longitudinal end of the tubular burner body (to be closed by this impermeable end cap) of which the surface of the impermeable end cap is at least partially curved, whereas the bending radii of each point on the impermeable end cap surface is larger than 3 times the metal thickness of the impermeable end cap material.

Preferably, radii larger than 4 times the metal thickness of the impermeable end cap material are used. An additional advantage of these large radius or radii, is that internal stresses in the impermeable end cap, due to the shaping of the impermeable end cap, are reduced to a minimum.

The border of the impermeable end cap and the longitudinal end of the tubular burner body has to engage closely.

Preferably, but not exclusively, this impermeable end cap is to be welded to the longitudinal end in such a way that the curvature of the impermeable end cap surface extends outwards of the tubular burner body. Hereafter, extending outwards from the tubular burner body is referred to as "convex". The impermeable end cap is welded to the longitudinal end over the impermeable end cap's lower border. The impermeable end cap may also be connected to the tubular burner body, having a curvature extending inwards to the tubular burner body. Hereafter, extending outwards from the tubular burner body is referred to as "concave".

The impermeable end cap may be curved over its whole surface, having bending radii larger than 3 times the metal thickness of the impermeable end cap material. However, the bending radius may differ for each point of the surface of the impermeable end cap. Preferably, the impermeable end cap is only bent at the outer border of the impermeable end cap, where the end cap is connected to the tubular burner body. In the inner part or zone of the surface of the impermeable end cap, the impermeable end cap is preferably substantially flat, having a bending radii being substantially infinite. "substantially infinite" is to be understood as larger than 10 times the maximum distance between to points of the border of the impermeable end cap.

When, according to the present invention, such impermeable end cap is welded to the longitudinal end of the tubular burner body, with a concave or convex curvature, the relatively large radius or radii will enable the impermeable end cap to compensate the difference in thermal expansion between tubular burner body and impermeable end cap, during combustion of combustible gas/air mixture at the burner slots, by slightly changing the radius or radii. This slight change prevents the occurrence of too large stresses over the welding between tubular burner body and impermeable end cap. As a result, thermal cracks may be avoided.

The tubular burner body and the impermeable end cap are made out of metal, e.g. metal or steel plate, preferably stainless steel. Preferably the same material is used for both elements. Metal thickness' of both tubular burner body and impermeable end cap ranging from 0.2 to 1.5 mm may be used, preferably ranging from 0.2 to 1mm, such as 0.3mm, 0.5mm, 0.6mm, 0.8mm or 1 mm.
Tubular burner body may be provided by different techniques. Usually, a tubular burner body is provided by rolling a tube out of a perforated metal plate. The tube is closed by welding the plate edges in axial direction, e.g. by laser of TIG-welding.

Usually, the impermeable end cap is pressed out of metal plate.

The lower border of the impermeable end cap and the longitudinal end of the tubular burner body may be welded to each other in several different ways, depending on the dimensions of the lower border of the impermeable end cap as compared to the circumference to the longitudinal end of the tubular burner body, either when the curvature is used in a concave or convex way.

In case the inner side of the lower border of the impermeable end cap engages the outer side of the longitudinal end of the tubular burner body, both impermeable end cap end tubular burner body are preferably spot welded or laser welded to each other.

In case the outer side of the lower border of the impermeable end cap engages the inner side of the longitudinal end of the tubular burner body, both impermeable end cap end tubular burner body are preferably spot welded or laser welded to each other.

In case the lower border of the impermeable end cap has essentially the same circumference as the longitudinal end of the tubular burner body, laser welding or TIG-welding welds the impermeable end cap and tubular burner body. They are so-to-say welded face to face, without an overlap of material of the impermeable end cap and the tubular burner body.

A person skilled in the art understands that a large range of dimensions, both of diameter and height of the premix burner may be obtained. Usually, the diameter is larger than 0.5cm, preferably it ranges from 2.5 to 25 cm, most usually however it ranges between 6 to 8 cm. A height of the tubular burner body preferably ranges from 10 to 50 cm, most usually in the range of 10 to 20. Even so, the tubular burner body is not to be understood as having a circular cross-section when cut longitudinally. Other cross sections may be used, such as elliptic or oval cross sections.

Such premix burners as subject of the invention may be used in heating devices, heating water or air, e.g. central heating systems and boilers.

Brief description of the drawings.

The invention will now be described into more detail with reference to the accompanying drawings wherein

- FIGURE 1 shows schematically a premix burner as subject of the invention .
- FIGURE 2 is a radial cut of a tubular burner body, being part of a premix burner as subject of the invention.
- FIGURE 3 is an impermeable end cap, being part of a premix burner as subject of the invention.
- FIGURE 4a is an axial cut of detail A out of FIGURE 1.
- FIGURE 4b is an axial cut of an alternative embodiment of the present invention.
- FIGURES 5a, 5b, 5c and 5d show different welding possibilities to connect an impermeable end cap and a tubular burner body as subject of the invention.
- FIGURES 6a, 6b, 6c, 6d and 6e show different impermeable end cap surfaces as subject of the invention.

Description of the preferred embodiments of the invention.

A part of a premix burner, to which the present invention relates, is shown in FIGURE 1. A tubular burner body 11 is closed at its longitudinal end 12 with an impermeable end cap 13, having a convex curvature. Both elements, being impermeable end cap 13 and tubular burner body 11, are welded to each other in a welding zone 14. Premix air-gas mixture is provided by a known mixing system to an appropriate inlet system 15. The premix air-gas mixture is forced through the burning slots and/or holes 16, which are provided in the tubular burner body 11. Leaving the burning slots and/or holes 16, the premix air-gas mixture is subjected to combustion.

A longitudinal cut II' at the longitudinal end 12 of the tubular burner body is shown in FIGURE 2. The longitudinal end 12 has an inner circumference 21 and an outer circumference 22. The material thickness of the tubular burner body is indicated by T1. An impermeable end cap 13 is shown into more detain in FIGURE 3. The impermeable end cap 13 comprises a lower border 31, which has an inner side 32 and an outer side 33. According to the invention, the impermeable end cap surface 34 is curved. The impermeable end cap has a material thickness as indicated by T2.

The thickness' T1 and T2 may be different, but an equal thickness is preferred in the range of 0.2 to 1.5mm e.g. in the range 0.4 to 1mm, most preferably 0.6mm. A preferred embodiment of a premix burner as shown in FIGURE 1 has a tubular burner body height between 10 and 14cm, e.g. 12 cm and a diameter of the tubular burner body of 7cm. Most preferably, tubular burner body and impermeable end cap are made out of stainless steel alloy.

An axial cut of detail A of FIGURE 1 is shown in FIGURE 4a. Again, an impermeable end cap 13 and a tubular burner body 11 are welded to each other in the welding zone 14. This welding zone has a thickness D. At least a part of the impermeable end cap surface 34 is curved, with a bending radius R. Preferably this curved part of the impermeable end cap surface is located near the welding zone 14. The curvature of the impermeable end cap surface extends outward from the tubular burner body (as indicated with flash 41).

An alternative axial cut of another embodiment of a premix burner as subject of the invention is shown in FIGURE 4b. An impermeable end cap with a curvature extending inwards the tubular burner body (as indicated with flash 42) is shown.

For the embodiments as shown in FIGURE 4a and 4b, a radius in the range of 2mm to 10mm is preferred, depending on the material thickness of the impermeable end cap. For a most preferred embodiment, with an impermeable end cap material thickness T2 of 0.6mm, a radius not smaller than 2.5mm is preferred.

As is illustrated in FIGURE 5a, 5b and 5c, there are different ways to weld impermeable end cap 13 and tubular burner body 11 to each other. In FIGURE 5a, the inner side 32 of the curved impermeable end cap 13 engages the outer circumference 22 of the tubular burner body 11. The impermeable end cap surface is a convex way. The welding zone 14 is characterized by an overlap of both impermeable end cap and tubular burner body over a distance D. Preferably D is kept smaller than 6mm. This welding may be done by spot welding, however preferably laser welding is used.

In FIGURE 5b, the outer side 33 of the curved impermeable end cap 13 engages the inner circumference 21 of the tubular burner body 11. The impermeable end cap surface is a convex way. The welding zone 14 is characterized by an overlap of both impermeable end cap and tubular burner body over a distance D. Preferably D is kept smaller than 6mm. This welding may be done by spot welding, however preferably laser welding is used.

Best results however are obtained by welding impermeable end cap and tubular burner body "face-to-face" as shown in FIGURE 5c. In this case, the lower border 31 of impermeable end cap 13 and the longitudinal end 12 of tubular burner body 11 have essentially the same circumference. They are places one to the other and are welded together by TIG-welding, but preferably by laser welding. An extra advantage of this connection is that at the welding zone 14, which thickness is usually less 6mm, there is no overlap of two layers of material (one from the

impermeable end cap, the other from the tubular burner body). Preferably, laser welding techniques are used to connect impermeable end cap and tubular burner body face-to-face. Using this technique, the thickness D of the welding zone 14 is reduced to a minimum. When the premix burner is heated due to combustion of a low rate of premix air-gas mixture, the difference in thermal expansion is only due to the difference in thermal expansion on tubular burner body and impermeable end cap.

In FIGURE 5d, the outer side 33 of the curved impermeable end cap 13 engages the inner circumference 21 of the tubular burner body 11. The impermeable end cap surface is a concave way. The welding zone 14 is characterized by an overlap of both impermeable end cap and tubular burner body over a distance D. Preferably D is kept smaller than 6mm. This welding may be done by spot welding, however preferably laser welding is used.

In the cases as shown in FIGURE 5a, FIGURE 5band FIGURE 5d, there is an extra additional thermal expansion difference, caused by the presence of a zone where two layers of material are present.

A lot of different curvatures are possible, as some examples are shown in FIGURE 6a and 6b. FIGURE 6a shows an impermeable end cap 13, which has an elliptic curvature. In each point of the impermeable end cap surface, a different radius may occur. An alternative is shown in FIGURE 6b, where an impermeable end cap 13 has a substantially flat zone 61, and a zone 62 at the border of the impermeable end cap which is curved inwards the tubular body of the premix burner as subject of the invention. The bending radii in the zone 61 and 62 are larger than 3 times the thickness of the impermeable end cap material. In zone 61, the bending radii are substantially infinite, at least larger than 10 times the diameter

63 of the circular impermeable end cap. It is clear that the tubular burner body has a diameter, which is essentially identical to the diameter 63.

It is also understood that, in case the tubular body does not have a circular cross-section, the border of the impermeable end cap and the longitudinal end of the tubular burner body have to engage closely. One understands that in this case, of zone 61, the bending radii are substantially infinite, at least larger than 10 times the largest distance between two points of the border of the impermeable end cap.

FIGURE 6c, FIGURE 6d and FIGURE 6e show an impermeable end cap 13, which has a W-like shape. In FIGURE 6c here, only a part 64 of the en cap 13 is curved, and this curvature is extending outwards from the tubular burner body 11. In FIGURE 6d, a large part of the impermeable end cap 13 is concave. FIGURE 6e shows an impermeable end cap which is partially convex (65) and partially concave (66)

A person skilled in the art understands that above given examples are not meant to be restrictive, nor that the tubular burner body has to have a circular radial cut.

CLAIMS

1. A premix burner comprising a tubular burner body and an impermeable end cap, said impermeable end cap closing said tubular burner body, said impermeable end cap being welded to said tubular burner body, characterized in that said impermeable end cap having an impermeable end cap surface, said impermeable end cap surface being at least partially curved, each point of said impermeable end cap surface having a bending radius R and a material thickness T, said each R being larger than 3xT.

2. A premix burner as in claim 1, wherein said curvature of impermeable end cap surface being at least partially concave.

3. A premix burner as in claim 1, wherein said curvature of impermeable end cap surface being at least partially convex.

4. A premix burner as in claim 1, wherein said curvature of impermeable end cap surface being at least partially concave and partially convex.

5. A premix burner as in claim 1 to 4, said impermeable end cap surface having a zone being substantially flat.

6. A premix burner according to claim 4, said impermeable end cap surface having a zone being substantially flat, said bending radii in said substantially flat zone being larger than 10 times the maximum distance between two points of the border of said impermeable end cap.

7. A premix burner as in claim 1 to 6, wherein said impermeable end cap comprises a lower border, said tubular burner body comprising a longitudinal end, said lower border and longitudinal end being welded to each other without overlap.

8. A premix burner as in claim 1 to 7, wherein said impermeable end cap and said tubular burner body being welded to each other by laser welding.

9. A premix burner as in claim 1 to 7, wherein said impermeable end cap and said tubular burner body are welded to each other by spot welding.

10. A premix burner as in claim 1 to 7, wherein said impermeable end cap and said tubular burner body are welded to each other by TIG-welding.

11. A premix burner as in claim 1 to 10, said tubular burner body having a height in the range of 10 to 50 cm.

12. A premix burner as in claim 1 to 11, said tubular burner body having a circular cross-section, having a diameter in the range of 0.5 to 25cm.

13. Use of a premix burner as in claim 1 to 12 in a central heating or water heating system.

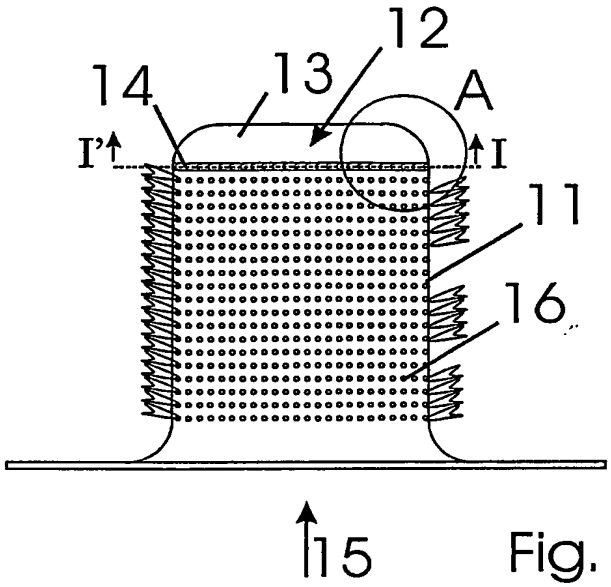

Fig. 1

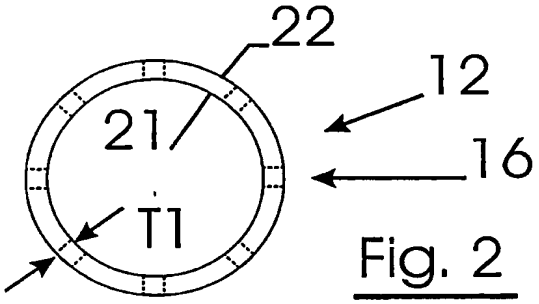

Fig. 2

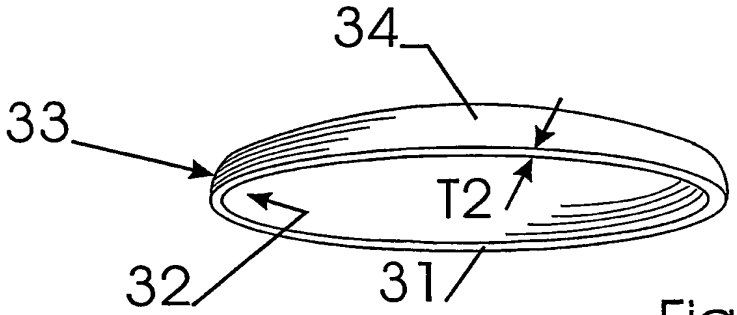

Fig. 3

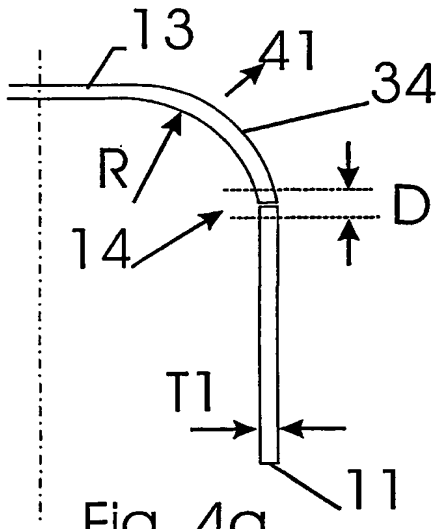

Fig. 4a

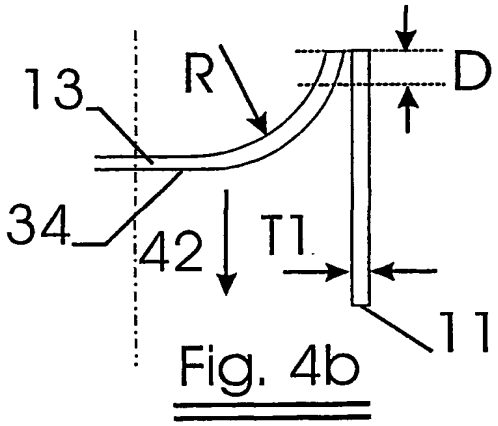

Fig. 4b

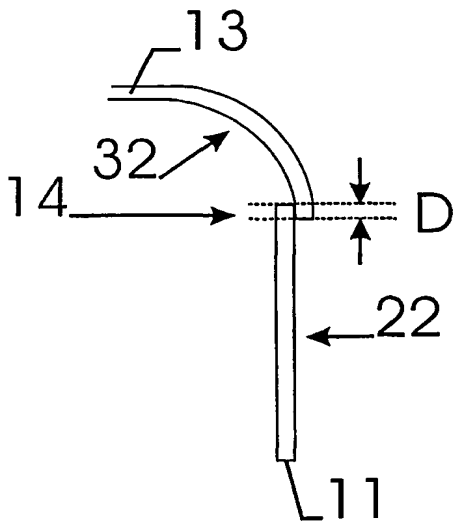

Fig. 5a

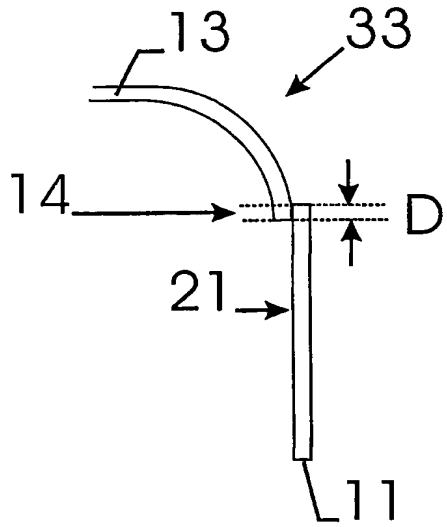

Fig. 5b

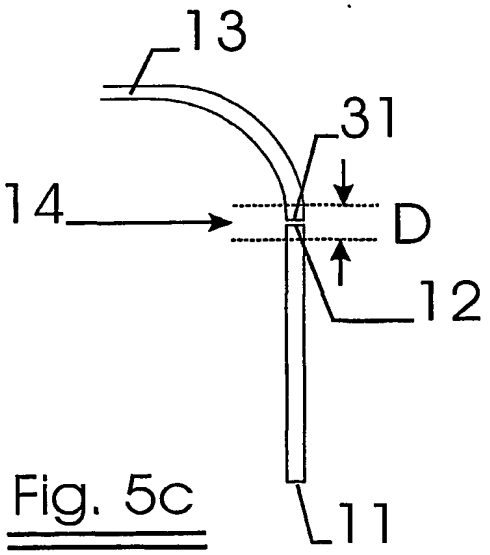

Fig. 5c

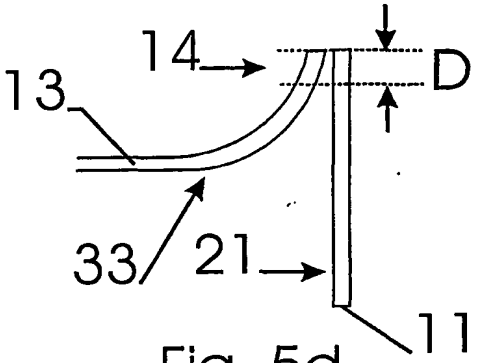

Fig. 5d

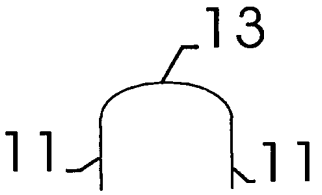

Fig. 6a

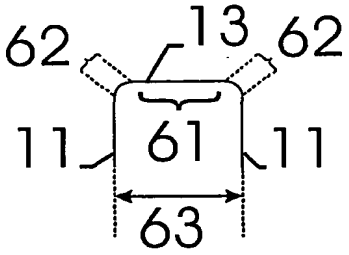

Fig. 6b

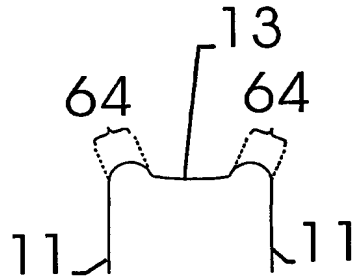

Fig. 6c

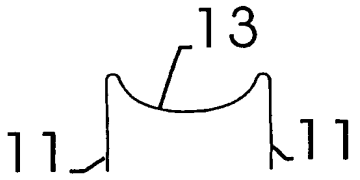

Fig. 6d

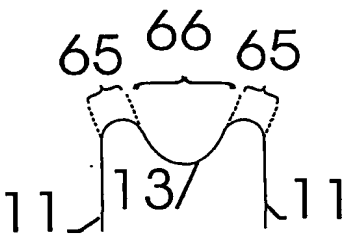

Fig. 6e

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/13700

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F23D14/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 1 258 784 A (HECTOR CLAEYS) 30 December 1971 (1971-12-30) figures 1,2 page 1, line 35 - line 45 page 3, line 10 - line 21 ---	1,2,5-7, 9,11,13
Y	FR 2 676 269 A (VIESSMANN HANS) 13 November 1992 (1992-11-13) page 1, paragraph 1 page 2, line 30 -page 4, line 2 page 5, line 32 -page 6, line 2 page 6, line 25 - line 33 figures 1-4 ---	1,2,5-7, 9,11,13
A	GB 1 423 829 A (GREAVES D V) 4 February 1976 (1976-02-04) page 1, line 94 -page 2, line 8 figure 1 ---	3
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
7 March 2002	14/03/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mougey, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/13700

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 245 084 A (SMITH CORP A O) 11 November 1987 (1987-11-11) figure 1 column 3, line 53 -column 4, line 1	4
A	EP 0 905 446 A (BOSCH GMBH ROBERT) 31 March 1999 (1999-03-31) column 1, line 47 - line 51	8
A	US 5 050 385 A (HIROSE FUMIYUKI ET AL) 24 September 1991 (1991-09-24) column 3, line 55 - line 62	10
A	US 5 211 552 A (TIDBALL RICHARD K ET AL) 18 May 1993 (1993-05-18) figure 1 column 4, line 10 - line 24	1,2
A	WO 92 19920 A (COUSSEMENT BRUNO) 12 November 1992 (1992-11-12) figure 9 page 19, line 14 -page 20, line 12	11,12
A	US 1 874 346 A (HERMAN PASCHKE CHARLES) 30 August 1932 (1932-08-30) page 1, line 48 -page 2, line 68 figure 1	1,2
A	US 5 743 727 A (RODGERS IAN M) 28 April 1998 (1998-04-28) column 3, line 12 - line 36; figure 3	1,3,5,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 01/13700

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 1258784	A	30-12-1971	BE	709591 A	30-05-1968
			DE	1901967 A1	02-10-1969
			FR	1597229 A	22-06-1970
			GB	1259080 A	05-01-1972
			NL	6900559 A	22-07-1969
FR 2676269	A	13-11-1992	DE	9102991 U1	16-07-1992
			BE	1005087 A6	13-04-1993
			CH	686387 A5	15-03-1996
			FR	2676269 A3	13-11-1992
			IT	226342 Z2	16-06-1997
GB 1423829	A	04-02-1976	IT	999688 B	10-03-1976
EP 0245084	A	11-11-1987	US	4721456 A	26-01-1988
			CA	1283351 A1	23-04-1991
			EP	0245084 A1	11-11-1987
			JP	2084626 C	23-08-1996
			JP	7117218 B	18-12-1995
			JP	62261812 A	14-11-1987
EP 0905446	A	31-03-1999	DE	19742089 A1	25-03-1999
			EP	0905446 A2	31-03-1999
US 5050385	A	24-09-1991	JP	1450446 C	11-07-1988
			JP	59066619 A	16-04-1984
			JP	62057892 B	03-12-1987
			DE	3360573 D1	19-09-1985
			EP	0107822 A1	09-05-1984
US 5211552	A	18-05-1993	NONE		
WO 9219920	A	12-11-1992	FR	2654190 A1	10-05-1991
			FR	2654200 A1	10-05-1991
			EP	0427650 A1	15-05-1991
			WO	9219920 A1	12-11-1992
			EP	0429380 A1	29-05-1991
US 1874346	A	30-08-1932	NONE		
US 5743727	A	28-04-1998	EP	0854322 A2	22-07-1998